REMARKS

Reconsideration of this Application is respectfully requested. Applicants have addressed every objection and ground for rejection stated in the Office Action mailed February 27, 2003, Paper No. 23, and believe the Application is now in condition for allowance.

The undersigned thanks the Examiner for the interview and the opportunity to discuss the scope of U.S. Patent No. 6,514,640 to Armand et al., and to discuss the status of the two Information Disclosure Statements first filed September 7, 2001 and October 11, 2001, and resubmitted July 18, 2002. Care has been taken in the preparation of this Amendment to ensure that the remarks herein correspond to the substance of the interview conducted on March 31, 2003.

1. Statement of the Case and Status of the Claims.

The present invention provides a novel electrode active material, as well as electrodes and batteries containing the same. The material has the nominal formula $LiFe_{1-y}M_yPO_4$, wherein M is selected from the group consisting of Be, Mg, Ca, Sr, Ba, and mixtures thereof; and $0 < y < 1$.

Claims 135 - 176 are currently pending in the present Application. Upon entry of the present Amendment, Claims 136, 139, 140, 142, 143, 145, and 152 will be amended, and new Claims 177 and 178 will be added. Claims 140, 143, and 145 have been amended, and new Claims 177 and 178 have been added, to specify that the claimed compound is a single phase material. Claim 139 has been amended to recite that the compound of Claim 148 has an olivine structure. Claims 136 and 142 have been amended to correct a typographical error in the Claims. Support for these amendments and new Claims can be found in the Application as filed.

Claims 135 - 147, 152 - 161, 165 - 172, and 176 stand rejected under 35 U.S.C. §103(a) as being obvious in view of U.S. Patent No. 6,514,640 to Armand et al. ("Armand '640").

The Examiner stated in the Office Action that the subject matter of Claims 148 - 151, 162 - 164, and 173 - 175 would be allowable if rewritten in independent form, including all of the limitations of the base claim and any intervening claims. The Examiner noted that the prior art of record fails to suggest compounds with an olivine structure and the empirical formula $LiFe_{1-y}Ca_yPO_4$, wherein $0 < y \leq 0.2$. Applicants thank the Examiner for her consideration of these Claims, and for deeming the subject matter thereof allowable over the prior art of record. Applicants will refrain from amending the Application in accordance with the Examiner's suggestion, at this time, in order to provide the Examiner the opportunity to consider Applicants' remarks presented herein and during the interview.

2. U.S. Patent No. 6,514,640 to Armand et al.

Claims 135 - 147, 152 - 161, 165 - 172, and 176 stand rejected under 35 U.S.C. §103(a) as being obvious in view of U.S. Patent No. 6,514,640 to Armand et al. ("Armand '640").

Armand '640 discloses a class or genus of "*ordered*" olivine compounds defined by the general formula $LiMPO_4$, wherein M is a first row transition metal (e.g. $LiFePO_4$) or a combination of first row transition metals (e.g. $LiFe_{1-x}Ti_xPO_4$). (See, Col. 2, ll. 14-27).

Armand '640 also discloses an extremely large class or genus of "*modified*" olivine compounds defined by the general formula:

$$Li_{x+y}M_{1-(y+d+t+q+r)}D_dT_tQ_qR_r(PO_4)_{1-(p+s+v)}(SO_4)_p(SiO_4)_s(VO_4)_v, \qquad (I)$$

wherein:

M may be Fe^{2+} or Mn^{2+} or mixtures thereof;

D may be a metal having a +2 oxidation state, preferably Mg^{2+}, Ni^{2+}, Co^{2+}, Zn^{2+}, Cu^{2+}, or Ti^{2+};

T may be a metal having a +3 oxidation state, preferably Al^{3+}, Ti^{3+}, Cr^{3+}, Fe^{3+}, Mn^{3+}, Ga^{3+}, Zn^{3+}, or V^{3+};

Q may be a metal having a +4 oxidation state, preferably Ti^{4+}; Ge^{4+}, Sn^{4+}, or V^{4+}; and

R may be a metal having a +5 oxidation state, preferably V^{5+}; Nb^{5+}, or Ta^{5+}.

Armand '640 states that the "modified" olivine general formula (I) is subject to the following four "conditions."

1. $0 \leq x \leq 1$;
2. $y + d + t + q + r \leq 1$;
3. $p + s + v \leq 1$; and
4. $3 + s - p = x - y + t + 2q + 3r$.

Claims 135 - 147 of the present Application recite, among other things, a compound having the general nominal formula $LiFe_{1-y}Mg_yPO_4$, wherein $0 < y < 1$. Claims 153 - 161 and 165 recite, among other things, an electrode comprising the $LiFe_{1-y}Mg_yPO_4$ compound. Claims 166 - 172 and 176 - 177 recite, among other things, a battery comprising the $LiFe_{1-y}Mg_yPO_4$ compound.

The Examiner has asserted that although "[t]he disclosure of Armand et al. differs from applicants' claims in that Armand et al. do not explicitly recite the compound $LiFe_{1-y}Mg_yPO_4$ as a cathode material . . . applicants' invention as a whole would have been obvious to one of ordinary skill in the art based on the Armand et al. reference."

In chemical cases, to establish a *prima facie* case of obviousness under Section 103(a) in view of a single prior art reference, (1) a claimed species must fall within or be embraced by the genus taught in the reference, and (2) the reference must provide some motivation or suggestion to choose the claimed species from among the compounds defined by the genus.

Applicants submit that the claimed $LiFe_{1-y}Mg_yPO_4$ species is not obvious in view of the teachings of the Armand '640 patent. First, the claimed $LiFe_{1-y}Mg_yPO_4$ species is not *embraced* by the genus defined by the "modified" olivine general formula (I) described in the Armand '640 patent. Second, the teachings of the Armand '640 patent do not *suggest* the claimed $LiFe_{1-y}Mg_yPO_4$ species.

A. Applicants' claimed $LiFe_{1-y}Mg_yPO_4$ species does not fall within the genus defined by the Armand '640 "modified" olivine general formula.

Applicants' claimed $LiFe_{1-y}Mg_yPO_4$ species is not obvious in view of the Armand '640 patent, because the claimed species does not fall within the genus of compounds defined by the Armand '640 "modified" olivine general formula (I).

Armand '640 states that the "modified" olivine general formula (I) is subject to the following four "conditions."

1. $0 \leq x \leq 1$;
2. $y + d + t + q + r \leq 1$;
3. $p + s + v \leq 1$; and
4. $3 + s - p = x - y + t + 2q + 3r$.

The fourth "condition" ($3 + s - p = x - y + t + 2q + 3r$) can be arithmetically rewritten as follows:

$$3 = p - s + x - y + t + 2q + 3r.$$

The fourth "condition" requires the presence of at least some amount of a trivalent element T^{3+}, a quadravalent element Q^{4+} and/or a pentavalent element R^{5+}, because t, q and/or r must be greater than 0 in order to satisfy the fourth "condition." This is due to the fact that x and p each can be no greater than 1, per the first and third "conditions," respectively. It follows that the sum of x and p can be no greater than 2. Therefore, t, q and/or r must be greater than 0 so that the sum of p, x, t, q , and r equals at least 3. This is assuming that y and s equal 0. In the case where y and s do not equal 0, then the sum of p, x, t, q , and r will be greater than 3.

Armand '640 teaches through application of the fourth "condition," single ion *aliovalent* substitution of M^{2+} with T^{3+}, Q^{4+} and/or R^{5+}, but not single ion *isocharge* substitutions of M^{2+} with D^{2+} by itself. In contrast, the claimed $LiFe_{1-y}Mg_yPO_4$ species represents a single-ion, non-transition metal *isocharge* substitution of Fe^{2+} with Mg^{2+}.

In order to arrive at Applicants' claimed $LiFe_{1-y}Mg_yPO_4$ species from the Armand '640 "modified" olivine general formula (I), one would have to pick and choose from among all the possible variables, the following values and substitute them into the "modified" olivine general formula (I).

1. $x + y = 1$;
2. $M = Fe^{2+}$;
3. $D = Mg^{2+}$ and $0 < d < 1$; and
4. t, q, r, p, s and $v = 0$.

To compare the substituents of Applicants' claimed $LiFe_{1-y}Mg_yPO_4$ species to the substituents of the Armand '640 "modified" olivine general formula (I), d, t, q, r, p, s and v must equal 0, and $x + y = 1$. It follows that if t, q, r, p, s and $v = 0$, then the fourth "condition" $(3 + s - p = x - y + t + 2q + 3r)$ is simplified to:

$$3 = x - y.$$

The Armand '640 first "condition" requires that $0 \leq x \leq 1$. Substituting the highest possible value for x into the simplified equation above yields $3 = 1 - y$. Hence, it is clear that there are no possible values for either x or y which could be chosen to satisfy the simplified fourth "condition," namely $3 = x - y$, when, as claimed by Applicants, $x + y = 1$. This is because x must be ≥ 3 in order to satisfy the simplified fourth "condition," yet the first "condition" requires that $0 \leq x \leq 1$. In other words, application of the four "conditions" to the "modified" olivine general formula (I) prevents one from deriving the claimed $LiFe_{1-y}Mg_yPO_4$ species. Therefore, the claimed $LiFe_{1-y}Mg_yPO_4$ species is not embraced by the genus defined by the Armand '640 "modified" olivine general formula (I).

Accordingly, because Applicants' claimed $LiFe_{1-y}Mg_yPO_4$ species is not embraced by the genus defined by the Armand '640 "modified" olivine general formula (I), Applicants submit that the $LiFe_{1-y}Mg_yPO_4$ species should not be deemed obvious in view of the teachings of the '640 Armand patent.

modified "4 conditions" ... error?

B. The teachings of the Armand '640 patent do not *suggest* the claimed $LiFe_{1-y}Mg_yPO_4$ species.

The teachings of the Armand '640 patent do not *suggest* the claimed $LiFe_{1-y}Mg_yPO_4$ species. The Armand '640 "modified" olivine general formula (I) describes an extremely large genus of compounds. The Armand '640 patent provides no express teachings which would motivate one to pick and choose from among all of the variables of the very large genus of compounds defined by the Armand '640 "modified" olivine general formula (I), to choose the particular selections to arrive at the claimed $LiFe_{1-y}Mg_yPO_4$ species. One would have to pick and choose from among the numerous selections for each of M, D, T, Q and R in order to arrive at the claimed $LiFe_{1-y}Mg_yPO_4$ species. Furthermore, one would have to pick and choose values for

each of x, y, d, t, q, r, p, s and v in order to arrive at the claimed $LiFe_{1-y}Mg_yPO_4$ species. The Armand '640 patent fails to provide any particular reason why one should pick and choose the combination of Fe^{2+} for M and Mg^{2+} for D without any selection for T, Q and R. The Armand '640 patent fails to provide any particular reason why one should exclude all the other possibilities for M and D, all the possibilities for T, Q and R, and all possibilities for substitution of the PO_4^{3-} polyanion, to arrive at the claimed $LiFe_{1-y}Mg_yPO_4$ species. Therefore, the Armand '640 patent does not *suggest* the claimed $LiFe_{1-y}Mg_yPO_4$ species.

The Examiner has asserted that the claimed $LiFe_{1-y}Mg_yPO_4$ species is obvious in view of the Armand '640 patent because Mg^{2+} is a preferred element for D, and "Mg^{2+} is given as a specific example of a cation isocharge with Fe^{2+} (column 2, lines 42-57) . . .." Applicants respectfully submit that these two teachings must not be viewed in isolation. Rather, the teachings of the Armand '640 patent must be viewed in its entirety, *as a whole*. Applicants submit Armand '640, *as a whole*, does not motivate one to *select* the claimed $LiFe_{1-y}Mg_yPO_4$ species from among the very large genus of compounds defined by the Armand '640 "modified" olivine general formula (I). The Armand '640 patent fails to provide any particular reason why one should pick and choose Fe^{2+} for M and Mg^{2+} for D without also making a selection for T, Q and R.

It is submitted, the Armand '640 patent actually *teaches away* from the claimed $LiFe_{1-y}Mg_yPO_4$ species. Armand '640 describes modifying a pristine olivine compound by aliovalent or isocharge substitutions to provide "better" or increased ionic diffusivity ("ionic conductivity") *and* electronic conductivity, as compared to electrode materials having a pristine "ordered" olivine structure (e.g. $LiMPO_4$, wherein M is a first-row transition metal or a mixture of first-row transition metals). (See, Col. 2, ll. 50-53; Col. 13, ll. 60-63; and Col. 14, ll. 3-8).

First, the preference in Armand '640 for enhancing ionic conductivity is partial substitution of the *anion* moiety (e.g. Si for P). In particular, Armand '640 states that "disorder on the anionic site provides preferential diffusion sites for Li^+." (Col. 14, ll. 15-16).

Second, the preference in Armand '640 for enhancing electronic conductivity is substitution that allows for the coexistence of transitions metals in two difference oxidation states in the same phase. Armand '640 teaches that the presence of Fe^{2+}/Fe^{3+} or Mn^{2+}/Mn^{3+} in the same phase, and/or interaction between elements having redox levels close to those of Fe and Mn (e.g. $Fe^{2+}/Ti^{4+} \leftrightarrow Fe^{3+}/Ti^{3+}$), yields enhanced electronic conductivity. (Col. 14, ll. 8-14). Armand '640 does not teach how one achieves the presence of Fe^{2+}/Fe^{3+} or Mn^{2+}/Mn^{3+} in the same phase through modification of the olivine structure. However, Armand '640 does teach substitution of M with *transition metals* having redox levels close to those of Fe^{2+} and Mn^{2+}.

Therefore, the preferences taught in Armand '640 to achieve enhanced electronic ***and*** ionic conductivity over the pristine "ordered" olivine structure, are to partially substitute or modify ***both*** the cation (M) moiety ***and*** the anion moiety of the pristine ordered olivine structure. It should also be noted that in the only example provided in Armand '640 for a modified olivine (Example 2), both the cation moiety and the anion moiety were modified

In contrast, the claimed $LiFe_{1-y}Mg_yPO_4$ species represents an example wherein only the cation (M) moiety of the olivine structure is modified, namely by partially substituting Mg^{2+} for Fe^{2+}. Furthermore, Mg is a *non-transition* metal, which does not undergo oxidation/reduction upon charge/discharge of the $LiFe_{1-y}Mg_yPO_4$ active material. Therefore, not only does the claimed $LiFe_{1-y}Mg_yPO_4$ species lack substitution of the anion moiety, the claimed $LiFe_{1-y}Mg_yPO_4$ species also lacks substitution of the cation (Fe^{2+}) moiety with a *transition metal*.

Therefore, because the Armand '640 patent teaches that both substitutions are preferable in order to achieve the better properties over the prestine "ordered" olivine compound, namely enhanced ionic and electronic conductivity, the Armand '640 patent teaches away from the claimed $LiFe_{1-y}Mg_yPO_4$ species.

B. Summary

Applicants submit that the claimed $LiFe_{1-y}Mg_yPO_4$ species is not obvious in view of the teachings of the Armand '640 patent. First, the claimed $LiFe_{1-y}Mg_yPO_4$ species is not *embraced* by the genus defined by the "modified" olivine general formula (I) described in the Armand '640 patent. Application of the four "conditions" of the general formula does not lead to the claimed $LiFe_{1-y}Mg_yPO_4$ species from the "modified" olivine general formula (I).

Second, the teachings of the Armand '640 patent do not *suggest* the claimed $LiFe_{1-y}Mg_yPO_4$ species. The Armand '640 "modified" olivine general formula (I) describes an extremely large genus of compounds. However, the Armand '640 patent provides no express teachings which would motivate one to pick and choose from among from all of the variables of the very large genus of compounds defined by the Armand '640 "modified" olivine general formula (I) to arrive at the claimed $LiFe_{1-y}Mg_yPO_4$ species.

It is further submitted, the Armand '640 patent teaches away from the claimed $LiFe_{1-y}Mg_yPO_4$ species, because Armand '640 teaches that modification of both the anion and cation moieties is preferable in order to achieve the better properties over the prestine "ordered" olivine compound, namely enhanced ionic and electronic conductivity. Applicants' claimed $LiFe_{1-y}Mg_yPO_4$ species, in contrast, represents a compound wherein only the cation (M) moiety of the olivine structure is modified, namely by partial substitution of Mg^{2+} for Fe^{2+}. The claimed

$LiFe_{1-y}Mg_yPO_4$ species lacks substitution of the anion moiety, and also lacks substitution of the cation (Fe^{2+}) moiety with a *transition metal*.

Therefore, Applicants respectfully submit that amended Claims 135 - 147, 153 - 161, 165 - 172, and 176, and new Claim 177, are patentably distinct from Armand '640. Accordingly, Applicants respectfully request allowance of these Claims.

3. Conclusion.

In view of the remarks presented herein, Applicants submit that every objection and ground for rejection stated in the Office Action mailed February 27, 2003, Paper No. 23, have been overcome. Accordingly, Applicants respectfully request allowance of all pending Claims.

Should anything further be required, the Examiner is respectfully requested to telephone the undersigned at 702-558-1071.

Respectfully submitted,

Dated: April 4, 2003

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MARKED-UP VERSION OF CLAIMS

136. (AMENDED) A compound of Claim 135, wherein $0 < y$ [≤] ≤ 0.5.

139. (AMENDED) A compound of Claim 135, wherein [M is selected from the group consisting of Mg, Ca, Ba, and mixtures thereof] said compound has an olivine structure.

140. (AMENDED) A compound of Claim 139, wherein [M is a mixture of metals selected from the group consisting of Mg, Ca, and Ba] said compound is a single phase compound.

142. (AMENDED) A compound of Claim 141, wherein said compound is represented by the nominal formula $LiFe_{1-y}Mg_yPO_4$; and $0 < y$ [≤] ≤ 0.5.

143. (AMENDED) A compound of Claim 142, wherein [$0.2 \leq y \leq 0.5$] said compound is a single phase compound.

145. (AMENDED) A compound of Claim [141 wherein $0.1 < y < 0.2$] 144, wherein the compound is a single phase compound.

152. (AMENDED) A compound of Claim [135] 148 which has an olivine structure.

177. (NEW) An electrode of Claim 157, wherein said active material is a single phase compound.

178. (NEW) A lithium battery of Claim 166, wherein said active material is a single phase compound.